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ABSTRACT

Two experiments involving 44 normal hearing and 26 hearing impaired children (7 to 12 years old) investigated children's use of sentence context to identify words in sentences that are not clearly intelligible. In Experiment 1, Ss read incomplete sentences and chose which of two word pictures best completed the sentence. From these responses, 12 sentences were identified (eight sentences in which rhyming test words were predictable from the context and four in which one word from the test word pair was not predictable). In Experiment 2, twenty-one of the same hearing impaired children, who met strict speech discrimination training criteria, heard variations of the 12 sentences over headsets in which the relationship between a context word and one of a rhyming test word pair was either reasonable, unreasonable, or neutral. After each sentence, the child decided whether he had heard the test word or its alternative which differed in either the initial or final consonant. Significantly more correct identifications were made on the reasonable and neutral sentences than on the unresonable ones. Average means were 81% on the reasonable sentence, 64% on the neutral ones, and 34% on the unreasonable ones. (Author)

Relations between Word Meanings and Identification of Words in Spoken Sentences by Hearing-Impaired Children

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NTID's principal goal in doing research is to influence the education, training and career placement of deaf citizens through systematic examination of issues related to deafness. As one part of NTID's total research effort, the Department of Research and Development conducts descriptive and experimental research. Research findings are used in the development of programs and materials in the areas of learning and instruction, personal and social growth, and career development of deaf students. This document was developed in the course of an agreement with the U.S. Department of Health, Education and Welfare.

Educational Implications of a Study on Relations between Word Meanings and Identification of words in Spoken Sentences by Hearing-Impaired Children

The paper entitled "Relations between Word Meanings and Identification of Words in Spoken Sentences by Hearing-Impaired Children," describes research conducted in a controlled experimental setting. This addendum considers possible implications of the study for the classroom. In making recommendations for the classroom, liberty is taken to be somewhat speculative.

The results idicate that hearing-impaired children with sufficient residual hearing do use sentence context to identify words in sentences that are not clearly intelligible. Moreover, children can use context even when there is not an opportunity for lipreading.

Making children aware of how they can use context to better understand sentences may improve their listening skills. Such awareness may also help improve reading and notetaking because these are activities in which anticipating words on the basis of context may improve performance.

A possible exercise the teacher could use in the classroom would be to read aloud to the children sentences similar to the ones used in the investigation. These sentences may help children discover how they use context in listening to sentences. Two kinds of sentences can be used: (a) Sentences that contain contextual cues. (e.g. The little dog has a tail.) (b) Sentences that do not contain contextual cues. (e.g. The tail was grey.) After hearing one of these sentences, the child can be asked which of the similar sounding alternatives is correct (e.g. pail vs. tail.).

Word discrimination training seems to play a key role in the use of contextual

Abstract

In Experiment 1, 44 normal-hearing children read incomplete sentences and chose among two alternatives the word-picture that best completed the sentence. From these responses, 12 sentences were identified (4 pairs in which rhyming test words were predictable from the context and four in which one from the test-word pair was not predictable). These 12 sentences were then presented to 26 hearing-impaired children who responded in the same general manner as the normal-hearing children. In Experiment 2, 21 of the same 26 hearing-impaired children, who met strict speech discrimination training criteria, heard variations of the 12 sentences over headsets in which the relationship between a context word and one of a rhyming test-word pair was either reasonable, unreasonable, or neutral. After each sentence, the child decided whether he had heard the test word or its alternative which differed in either the initial or final consonant. Significantly more correct identifications were made on the reasonable and neutral sentences than on the unreasonable ones. Average means were 81% on the reasonable sentence, 64% on the neutral ones and 34% of the unreasonable ones.

Relations between Word Meanings and Identification of Words in Spoken Sentences by Hearing-Impaired Children

Psycholinguistic studies with normal-hearing persons indicate that contextual cues facilitate the identification of other words by restricting the number of possible responses (e.g., Miller and Isard, 1963; Leventhal, 1973). For example, the sentence context, "The cup was placed on the _____," provides information that can be used in recognizing the next word (i.e. "table"). Context includes both the syntactic and semantic information in a sentence that primes a listener to expect particular member words (Miller and Isard, 1963). The present study examines a semantic aspect of context, and relationships between word meanings.

Hearing-impaired persons often have difficulty following speech because they cannot hear or lipread certain speech sounds that permit the identification of particular words. It may be possible, however, for impaired hearers to extract semantic and syntactic information from intelligible words that partly compensates for words that are not intelligible. Recent work with the Speech Perception in Noise (SPIN) test has, in fact, demonstrated use of contextual cues by adults with mild or moderate hearing losses. (Kalikow, Stevens, and Elliott, 1977; Kalikow, Stevens, Gerstman, and Morrison, 1976).

The extent to which a hearing-impaired child can use contextual cues is not clear, however, for two reasons. First, if the child loses his hearing early in life, he may acquire a different linguistic base than the normal-

hearing child. Consequently, the child may experience difficulty using syntactic and semantic information that can facilitate understanding difficult to hear speech. In addition, the decrement in hearing ability may force the listener to code each word as he hears it because he cannot identify enough words to form a useful contextual base.

The perception of spoken sentences by hearing-impaired children has received little research attention, with studies by Wilcox and Tobin (1974), Davis and Blaydell (1975) and Erber and McMahon (1976) being exceptions. None of these studies, however, investigated effects of sentence context upon identification of a particular word in a sentence. Study of the extent to which hearing-impaired children use context in listening to sentences may suggest procedures that will help them comprehend speech that it difficult to hear clearly.

The present study examined the extent that hearing-impaired children use contextual cues governed by relations between word meanings to facilitate the identification of certain words in spoken sentences. Experiment 1 measured the predictability of to-be-identified words (test words) in the context of printed sentences. Experiment 2 determined the extent to which hearing-impaired children could identify the same test words in an auditory presentation consisting of sentences employing different contextual words. The intent of these experiments was to observe the effects of manipulating semantic information upon ease in identifying a particular word; it was not to develop materials for testing.

Experiment 1

The primary purpose of Experiment 1 was to identify sentences in which normal-hearing children judged either (a) that the test word was predictable from the context, or (b) that the test word was not predictable from the context. An additional purpose of Experiment 1 was to compare the sentence-completion responses of normal-hearing and hearing-impaired children.

Method

Subjects: Subjects were 44 normal-hearing third and fourth graders and 26 hearing-impaired children enrolled in programs for the hearing-impaired at local public schools. The ages of the hearing-impaired children ranged from 7 to 12 years (mean 9.9), and the ages of the normal-hearing children ranged from 9-11 years (mean 9.8). The severity of loss for the hearing-impaired, as measured by the average of the pure-tone thresholds for the 500-2000 Hz range in the better ear, varied from 60 to 103 dB, with a mean of 79.8 dB. All had measurable hearing in the better ear at 500, 1000 and 2000 Hz.

Incomplete sentences: There were 11 three-sentence sets such as:

	Incomplete Sentence	Sentence Type	Responses
1.	The little girl has a _____.	Reasonable	pail/tail
2.	The little dog has a _____.	Reasonable	"
3.	The _____ was grey.	Neutral	"

For each of the 11 sets, there were two alternative responses. The reasonable sentences were written with the expectation that they would provide contextual cues. (They are called "reasonable" in order to contrast them with the "unreasonable" sentences which did not make sense and which were used in Experiment 2.) The neutral sentences were written with the expectation that contextual cues would be absent.

The incomplete sentences of the 11 sets were randomly distributed and printed in a booklet with two sentences per page. For each incomplete sentence, the two alternative words for completing the sentence (e.g., pail/tail) were printed below the sentence, with a picture for each alternative.

The experimenter read each incomplete sentence out loud, and then the child read the sentence silently and checked the word picture alternative that best completed the sentence. Three practice items preceded the 33 test items.

The normal-hearing children were tested as a group in their classrooms. The hearing-impaired children were tested individually in a quiet room. For the latter group, the experimenter used either speech or speech with signs, the communication mode being based upon that ordinarily used in the classroom.

Vocabulary test: A vocabulary test was administered to the hearing-impaired children prior to the sentence-completion test to insure that they knew the meanings of all the words. The vocabulary test consisted of the alternative words for completing the sentences (e.g., pail/tail) and of the key words in the incomplete sentences that pointed out the appropriate alter-

from among three sentences with distributions of 64%/36%. The distributions, in percentages, for the retained sentences are listed below:

1. The (pail/tail) was grey. 53/47
2. Please give him the (map/match). 50/50
3. Look at the (goat/boat) over there. 59/41
4. The (can/pan) goes on the shelf. 64/36

The distributions for the seven sentences that were discarded ranged from the aforementioned 64%/36% to 89%/11%. (The more frequent response is listed first when the distribution is not 50%/50%).

The eight reasonable sentences that were retained belonged to the same three-sentence sets as did the retained neutral sentences. These four pairs of reasonable sentences are shown in Table 1. For the seven discarded pairs of reasonable sentences, the distributions ranged from 98%/02% to 100%/00%. (The appropriate response is listed first.) Thus, selection of the retained sentences was actually based solely upon the neutral ones since the distributions for the retained and discarded reasonable sentences were similar.

Note that the selection of sentences for further study was based upon data summarizing normal-hearing children's responses. This selection procedure identified sentences with contextual cues that the normal-hearing children recognized. Thus, it was subsequently possible to evaluate hearing-impaired children's responses to contextual cues generally recognized by normal-hearing children. (Study of the hearing-impaired children's responses dealt only with the retained sentences, even though they had actually completed both the retained and discarded sentences.)

native (e.g., "girl" in the sentence, "The little girl has a _____.") For each vocabulary test item, a response form provided four pictures, one of which depicted the test word. After the experimenter had given a word by saying it and pointing to it on a list of printed words, he asked the child to point to the correct alternative on the four-picture form. The children gave correct responses to all of the words. The vocabulary test was not administered to the normal-hearing children, on the assumption that they were familiar with all the words.

Results

Selection of three-sentence sets with reasonable and neutral sentences: The procedure for selecting the "reasonable" and neutral sentences had two steps: (a) Calculating, for each sentence, the percentage of completions with each of the two alternative words; and (b) selecting the sentences with relatively optimal response distributions. For the 11 neutral sentences, the optimal distribution was a 50%/50% split. This distribution would verify that contextual cues were absent for the sentence; therefore, if the sentence was presented in an acoustical mode, performance should depend solely upon the acoustical cues of the test word. For the 22 reasonable sentences, the optimal distribution was 100%/0% in favor of the appropriate alternative (e.g., "The little dog has a tail (vs. pail)."). This distribution would indicate that context governed selection of the test word.

Three of the four neutral sentences that were retained for further study had distributions that were closer to 50%/50% than did the eight other sentences. The fourth neutral sentences that was retained was randomly selected

Comparison of responses of normal-hearing and hearing-impaired children to reasonable and neutral sentences: Table 1 also shows the responses of the hearing-impaired children to the reasonable sentences in the three-sentence sets that were retained for further study. Statistically significant

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Insert Table 1 about here

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differences in the distribution of responses for the two groups were observed for three of the eight reasonable and one of the four neutral sentences. The normal-hearing children gave the appropriate completion alternative more frequently than did the hearing-impaired children for (a) "The little girl had a (pail)," $\chi^2(1) = 11.56$, $p < .001$; (b) "The cook took the coffee from the (can)," $\chi^2(1) = 20.81$, $p < .001$; and (c) "You find (boats) on the sea," $\chi^2(1) = 3.48$, $p < .05$. For one neutral sentence, "Please give him the (match/map)," the selection pattern of the normal-hearing children was closer to a 50/50 split than was the pattern of the hearing-impaired children, $\chi^2(1) = 6.53$, $p < .02$, (normal-hearing = 50% match/50% map, hearing-impaired = 81% match and 19% map). Although there were these few differences in the responses of the two groups, the overall response patterns of the two groups were similar in the following respects: (a) For the reasonable sentences, the hearing-impaired children generally selected the alternative that the normal-hearing children considered appropriate. (b) For the neutral sentences, both groups distributed their selections among the two alternatives closer to a 50-50 response pattern than for the reasonable sentences.

Experiment 2

The purpose of Experiment 2 was to observe the effects of manipulating semantic information upon discrimination of alternative words with high acoustic confusability by hearing-impaired children. Three predictions were made:

1. Discriminating between two similar sounding words is more difficult when these words are presented in a sentence with neutral context than when they are presented in a sentence with a biasing word that is relatively easy to discriminate from a corresponding word in a second sentence. For example, it should be relatively easy for a child to discriminate between pail and tail if they occur in the respective sentences:

The little girl has a pail.

The little dog has a tail.

After hearing one of these sentences, the child is asked whether he heard pail or tail. In this case, the child will usually select the correct alternative because its meaning is consistent with that of the biasing word. On the other hand, it should be relatively difficult for the child to discriminate between pail and tail if he hears one of them in the neutral context, "The _____ was grey." Similar sounding pairs of words, such as pail and tail, are likely to be confused by impaired listeners. In Experiment 2 the alternatives for the test word always differed by one consonant and were based on consonant confusions for impaired hearers reported by Owens, Benedict and Schubert (1972).

2. Children will more frequently identify the correct word in a pair when it is in a sentence where the relationship between the biasing and test

word is reasonable than in one where the relationship is unreasonable, as in, "The little girl has a tail." If listeners perform better on sentences with a reasonable relationship between the biasing and the test word than on sentences with an unreasonable relationship, this pattern would suggest that biasing words are being accurately registered and related to the test word. Presumably, listeners would do worse on the unreasonable sentences because the biasing word would induce the listeners to ignore the acoustical information in the test word.

3. Children will less frequently identify the test word correctly when it is in a sentence with an unreasonable relationship between the biasing and the test word than when it is in a sentence with neutral context.

Method

Overview: Each of the two periods in Experiment 2 was comprised of word-discrimination training followed by sentence testing. The word-discrimination training was conducted to insure that the children could discriminate the biasing words in isolation. The subsequent sentence testing was conducted to observe effects of manipulating the biasing words upon discrimination of acoustically confusing words. In one period, this testing included sentences with a reasonable relationship between the biasing and test word; in the other period, the testing included sentences with an unreasonable relationship between the words. (Both periods included sentences with neutral context.) The word-discrimination training and the sentence testing will be described separately.

Word-discrimination training

Materials:

1. Two word lists were recorded on tapes by a male talker. Each had two practice words, followed by 12 words to be used subsequently in reasonable or unreasonable sentences. For List 1, the training words were selected from the pairs chicken-coffee and girl-dog, with each word being presented three times in the list in randomized order. For List 2, the training words were selected from the pairs fire-trip and farm-sea.

2. For each list, a separate sheet showed the words in type and corresponding pictures.

3. There were five response cards per list. Each card had four pictures: two depicting words on the list and two depicting foil words. For example, one of the cards had pictures of "dog," "girl," "star," and "broom," with the words from the list being "girl" and "dog."

All testing was conducted "face-to-face." First, the child was shown the sheet for a randomly selected list and asked to say or sign each word as he pointed to the corresponding picture. All children did this task correctly.

Next, the child was instructed to listen over headsets to words from the 12-item list and to point to the picture for the word on the response card. Whenever the child was correct, the trainer said "right." The criterion for completing training was 12 consecutive correct discriminations.

Subjects: Subjects were the same 26 hearing-impaired children who participated in Experiment 1. Twenty-one children met criterion by the fifth presentation of the 12-item list. The five children who did not meet criterion by the fifth presentation were dropped from the study.

Sentence testing: In sentence testing, the biasing words were identical to those used in discrimination testing. For example, if a child received word-discrimination training with a list that included the word dog, he was subsequently tested with a set of sentences that included, "The little dog had a tail." (If the period included reasonable sentences.)

The reasonable and neutral sentences obtained from Experiment 1 were also used in Experiment 2. In addition, a matching set of unreasonable sentences was generated by substituting the alternate response as the test word. (e.g. Inserting pail for tail, to make, "The little dog had a pail.") By using the same word in each of these forms, it was possible to control for the effect of variation in test words.

Experiment 2 was designed so that children did not hear the same sentence in each of the two periods. In one period, they heard four of the test words in reasonable sentences and the other four words in neutral sentenses. In the other period, they heard the latter four words in unreasonable sentences, and the former four in neutral ones. The presentation of reasonable or unreasonable sentences was counterbalanced across periods.

Eight lists were prepared for recording in order to achieve the counterbalancing and to vary the presentation order of test items. Each of these lists had 32 sentences, broken down into: (a) Two practice sentences, (b) six foil sentences, and (c) 24 test sentences. Each of the eight test sentences (four neutral, four reasonable or four unreasonable) was used three times in a list. The foil sentences were inserted in order to provide some relatively easy items and to increase the interval between repetitions of a test item. For each sentence, there was a card that depicted the test word and a similar sounding word (e.g., pictures of pail and tail).

Instructions were given face-to-face. Children were told that some of the sentences might be hard for them to understand; in addition, before receiving the unreasonable sentences, they were told that some of the sentences would be funny and not make sense.

The sentences were again presented over headsets. Immediately after hearing each sentence, children saw one of the cards depicting a test word and the other word in the pair. Selection of the picture for the word in the just-presented sentence constituted the measure of performance. Sentence-presentation rate was paced by the subject. In each period, children heard three repetitions of one 32-item list and three repetitions of a second list that contained the same items arranged in a different order.

Results

The neutral sentences were divided into the set that accompanied the reasonable sentences and the set that accompanied the unreasonable ones. Consequently, the experimental design had three factors: (a) Reasonable/unreasonable vs. neutral sentences (b) reasonable and accompanying neutral sentences vs. unreasonable and accompanying neutral sentences, and (c) pairs of trials. Table 2 shows the mean percent correct for reasonable, unreasonable and neutral sentences (with the data displayed separately for the 2 sets of neutral ones). These data are the proportion of correct selections of the test word for three pairs of trials. Since in responding to a sentence, the child always decided between two alternatives, chance performance level was .50.

Insert Table 2 about here

It was predicted that children would select the correct word more frequently when the biasing sentences were reasonable than when they were unreasonable. It was also predicted that children would not differ in the frequency in which they selected the correct word when the two sets of sentences were neutral. Given these predictions, the analysis of variance was expected to yield a significant interaction of the two relevant factors (reasonable/unreasonable vs. neutral and reasonable/neutral vs. unreasonable/neutral sentences). In fact, this was the outcome, $F(1,19) = 49.89$, $p < .001$. Follow-up analyses with Tukey's HSD test showed that children selected the correct word more frequently when the sentences were reasonable than when they were unreasonable ($p < .01$). Furthermore, there was not a significant difference in performance when the two sets were neutral.

Further analysis with the HSD test showed that children made more correct selections when the sentences were neutral than when they were unreasonable ($p < .01$), as had been predicted. However, children did not make significantly more correct selections in the reasonable sentences than in the neutral ones, although the means were in the predicted direction.

The analysis of variance yielded only one other significant effect: Children selected the correct word more frequently when the sentences were the reasonable and accompanying neutral ones than when they were the unreasonable and accompanying neutral ones, $F(1,19) = 44.04$, $p < .001$.

Discussion

The principle findings were (a) that the hearing-impaired children made more correct selections of the test word in the reasonable sentences than in the unreasonable ones; and (b) they made fewer correct selections in the unreasonable sentences than in the neutral ones. Furthermore, children made more correct selections in the reasonable sentences than in the neutral ones, although this difference was not statistically significant.

The finding that children did better on the reasonable sentences than on the unreasonable ones suggests that, in general, children extracted meaning from the biasing context and used this information to select the test word. In hearing a sentence such as, "The little dog has a tail," the child may have registered all the words but the test one, for which he could not tell acoustically whether he had heard a /p/ or a /t/; however, he could compensate for this confusion by using semantic knowledge that indicated that tail was the appropriate word. On the other hand, the poor performance on the unreasonable sentences suggests that, in this case, the contextual information overrode the acoustic cues. Of course, if the test alternatives had not been so similar sounding, context might not have had as strong an effect.

The intermediate performance when the sentences were neutral is also consistent with the interpretation that relations between word meanings governed selection of the test word. These sentences did not have word-meaning information that could either facilitate or interfere with selection of the correct test word.

This emphasis on the role of word meaning assumes that words serving as cues for normal-hearing children can also serve as cues for hearing-impaired children. This assumption is necessary because the sentences used to examine the effects of context were identified on the basis of normal-hearing children's recognition of their contextual cues. On the whole, the data from both Experiments 1 and 2 indicated that the hearing-impaired children also recognized these cues.

The discrimination training for the biasing words may have played an essential role in the manipulation of context to influence selection of the test word. For the reasonable sentences, the discrimination training may have increased the extent children registered the biasing words in subsequent sentence testing; consequently, more cues were available for inferring the correct test word. On the other hand, for the unreasonable sentences, the discrimination training may have made more cues available that were misleading. Consequently, the listener was more likely to ignore the acoustic cues in the test word. Results from a pilot study suggest that the word-discrimination training played an essential role (Stinson, 1976). This study did not include prior discrimination training for the biasing words, and the results indicated that, without the discrimination training, manipulation of context did not influence identification of the test word.

The findings of the present study are consistent with the proposition that sentence comprehension involves an intricate interplay between linguistic and perceptual processes. While there seem to be many techniques avaiable for diagnosing deficiencies in the auditory-perceptual process, there are few techniques for diagnosing and remediating the skills that link perceptual

and linguistic processes. Further description and understanding of these "linking" skills is needed since they are crucial in sentence comprehension, and consequently, in communication.

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Footnote

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Table 1

Normal-Hearing and Hearing-Impaired Children's

Responses to Incomplete Sentences

Pairs of incomplete sentences with possible responses in ( ) and the appropriate one underlined	Percentage of Appropriate and Inappropriate Responses			
	Normal Hearing[a]		Hearing Impaired[b]	
	Approp.	Inapp.	Approp.	Inapp.
1a. The little girl has a (pail/tail).	82	12	42	58
1b. The little dog has a (tail/pail).	98	2	96	4
2a. The cook took the coffee from the (can/pan).	98	2	54	46
2b. The cook took the chicken from the (pan/can).	94	6	89	11
3a. We need a (match/map) for the fire.	100	0	96	4
3b. We need a (map/match) for the trip.	100	0	96	4
4a. You find (goats/boats) on the farm.	100	0	96	4
4b. You find (boats/goats) on the sea.	100	0	92	8

[a] $n = 44$

[b] $n = 26$

Table 2

Mean Percent Correct for Reasonable, Unreasonable and Neutral Sentences

	Pairs of Trials					
	1 - 2		3 - 4		5 - 6	
	M	SD	M	SD	M	SD
Biasing Sentences						
Reasonable	.83	.14	.80	.16	.80	.16
Unreasonable	.35	.20	.33	.21	.33	.24
Neutral Sentences						
Set accompanied by reasonable	.65	.14	.65	.14	.63	.16
Set accompanied by unreasonable	.63	.16	.65	.17	.63	.16